RHYTHMIC BANDING AND BLEACH SPOTS IN VINDHYAN SANDSTONE.

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ABSTRACT.

Vindhyan sandstones in Khilchipur State, Central India, show rhythmic banding of the horizontal as well as concentric types. The banding is due to the diffusion of ferric oxide, limonite, or chloritic material derived from extraneous source. Iron oxide is leached out from the overlying basalts and precipitated in a crystalline siliceous mass—essentially a superimposed character. Intensity of colouration depends upon the molecular size and degree of granularity of the diffused material. The fact that the medium through which circulation takes place, is not a gel, does not in any way prevent the formation of Lisegang rings or bands. Bleach spots or deoxidation spheres in sandstone are due to reduction of ferric oxide and its subsequent removal by solutions in ferrous form.

INTRODUCTION.

During the investigation of the geology of the northern tracts of Khilchipur State, Central India, the writer came across certain horizons of Vindhyan sandstone,[1] horizontally disposed, with peculiar rhythmic banding of the horizontal as well as concentric type. A similar case of banding has been noticed by Tyrrell[2] in a block of riebeckite orthophyre from Holy Isle, Arran.

DESCRIPTION.

The specimens under observation are obtained from some of the upper beds of sandstones of the Bhojpur quarry (24°8′45″: 76°33′10″), and another small inlier in trap rock in Ghar River, near Rajpura village, E.N.E. of Bhojpur. The sandstones belong to the Upper Vindhyan. System (Purana age), while the trap rock consists of basaltic flows of late Cretaceous age, and of compact vesicular type. Rhythmic banding and bleach spots are more prominently seen at Bhojpur quarry. The colour bands run parallel to each other, and vary from one to six centimetres or often more in thickness. At the Rajpura occurrence, they are often eccentrically concentric, while generally they are concentric. At Bhojpur

[1] Chandoke, D. P.: Quart. Jour. Geol. Min. and Met. Soc. Ind., vol. III, No. 3, p. 138, 1931.

[2] Tyrrell, G. W.: "The Principles of Petrology," Methuen and Co., Ltd., London, 1st Edition, p. 222, 1926.

quarry, they run horizontally paralell to the bedding planes for long distances. The thickness and the intensity of colour of the bands is not uniform.

ORIGIN OF COLOURATION.

The diffused material in these cases of banding has been determined to be either of the following, (I) ferric oxide; (II) limonite and (III) chloritic material. It appears that the red or pink colour is due to ferric oxide, yellow due to limonite (derived by the hydration of ferric oxide), and green or apple-green due to chloritic material derived by the chemical decomposition and hydration of the femic constituents (principally augite) of the basalt overlying the sandstones. A case of similar type of rhythmic banding in a specimen of silicified rhyolite tuff from Mt. Popa, Upper Burma, due to ferric oxide from an extraneous source, has been described by Chhibber,[3] while a case in which the banding has been traced as due to manganese has been explained by Tarr.[4]

MODE OF COLOURATION.

The origin of ferruginous solutions in the case of the sandstones under observation is not difficult to explain. The iron oxide is essentially leached out from the femic constituents of the overlying trap rock, and circulated through the agency of solution, and precipitated after the reduction of the latter in a crystalline siliceous mass. This explanation seems more probably the case, since the banding appears to have been produced after the formation of the sandstones, as confirmed by a microscopic examination of these. Under the microscope, the sandstone is seen to consist of microcrystalline silica and fresh feldspar, and is fine or medium grained and fairly homogeneous. There is no evidence of the alteration of the texture of the rock where it is crossed by the coloured bands, showing thereby that the banding is a superimposed character, the silica of the sandstone having acted as a medium for the production of banding through the agency of iron-rich circulating solutions. In fact, the varying intensity of the colour bands depends not only on the amount of the colouring material, but also on the molecular size and degree of granularity of hematite, limonite or chloritic substances. The homogeneous char-

[3] Chhibber, H. L.: Geol. Mag., LXIV, No. 751, pp. 7-10, 1927.
[4] Tarr, W. A.: Jour. Geol., vol. XXVI, pp. 610-17, 1918.

acter of the grain of the rock is further a strong evidence to explain the horizontally parallel and often concentric character of the colour bands. It has been mentioned above that the ferruginous solutions may have diffused through the crystalline silica of the sandstone. It might be argued that such circulation or diffusion is possible only through a gel, but it has been shown by the experiments of Holmes[5] that gels are not essential for the production of Liesegang rings, as demonstrated by their formation in flowers of sulphur in loosely packed state. According to Liesegang[6], the banding is pro-

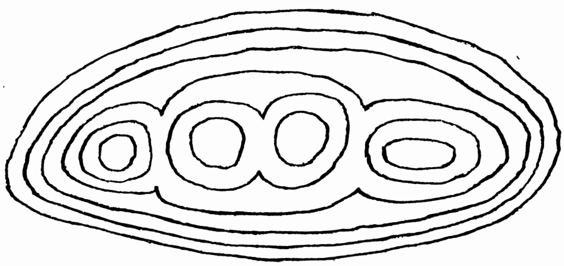

Fig. 1. Eccentrically concentric form of banding in Vindhyan sandstone.

duced by diffusion of solutions through the siliceous medium which already contains a substance with which the solution can react to form a precipitate. Liesegang further remarks: "As the solution advances, the new substance produced by reaction at first forms a supersaturated solution, which reaches precipitation at a certain stage. This uses up all the material in the neighbourhood, and the precipitation ceases until the diffused solution has advanced far enough to produce another zone of precipitation, and thus eventually banding is caused."[7] Thus the rusty or deep-red bands, which are often seen at Rajpura exposure, running roughly parallel to the exterior of a weathering stone (metamorphosed by contact metamorphism through a gradually cooling molten lava) are probably also due to rhythmic precipitation of colloidal iron oxide.

The above expressed view that the iron-bearing solutions derived their iron content through the chemical decomposition

[5] Holmes, H. M.: "Rhythmic Banding," Science, new series, vol. 46, p. 422, 1917.

[6] Liesegang: "Geologische Diffusionen," 1913.

[7] Tyrrell, G. W.: op. cit., p. 222, 1926.

of basaltic augite of the overlying flows is further confirmed by the occasional discovery of massive crystals of limonite at the weathered contact of sandstone and basalt, many of which were picked up from the southern top slope of the Bhojpur quarry. As will be naturally expected, the hydrogels lose a part of their water and gradually harden in course of time and give rise to various amorphous minerals, and hence the presence of limonite (often fibrous), and opal may be explained in this way. In addition to the presence of these two minerals, it is as yet left to ascertain the origin of hematitic jasperoids, fibrous chalcedony, hematitic kidney-ore, and agate occurring near the weathered junction of basalt and sandstone, especially at Bhojpur quarry. It must be understood that colloidal systems are essentially unstable, and accordingly further change leads to crystallization, which may be fibrous in the beginning, but may finally give rise to a coarse and granular texture. The "grape-bunch"-like, oolitic, and pisolitic structures occasionally met with in limonite at the above mentioned occurrence may also be traced to the colloidal origin of the original material of these minerals. During a search of the contact zone, the writer came across some specimens of sandstone very profusely disseminated by yellow ochre, giving the whole the appearance of a hard block of siliceous yellow ochre.

The bleach spots or deoxidation spheres encountered in some of the sandstone quarries at Karkari (24°12′28″: 76°30′27″) must be described as a case of colouration and decolouration of rocks to chemical phenomenon of some complexity.[8] These bleach spots occur as white spots in red sandstones, and may be explained to be due to the reduction of ferric oxide in these parts and subsequent removal in some soluble ferrous form by percolating water. A similar instance of de-oxidation is known from the Permian red sandstone from Ballochmyle, Ayrshire.[9]

[8] Richardson, W. H.: "Petrography of the Marlstone Ironstone of Leicestershire," Trans. Inst. Min. Eng., vol. 60, Pt. 4, pp. 337-344, 1921.
[9] Tyrrell, G. W.: op. cit., p. 220, 1926.

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